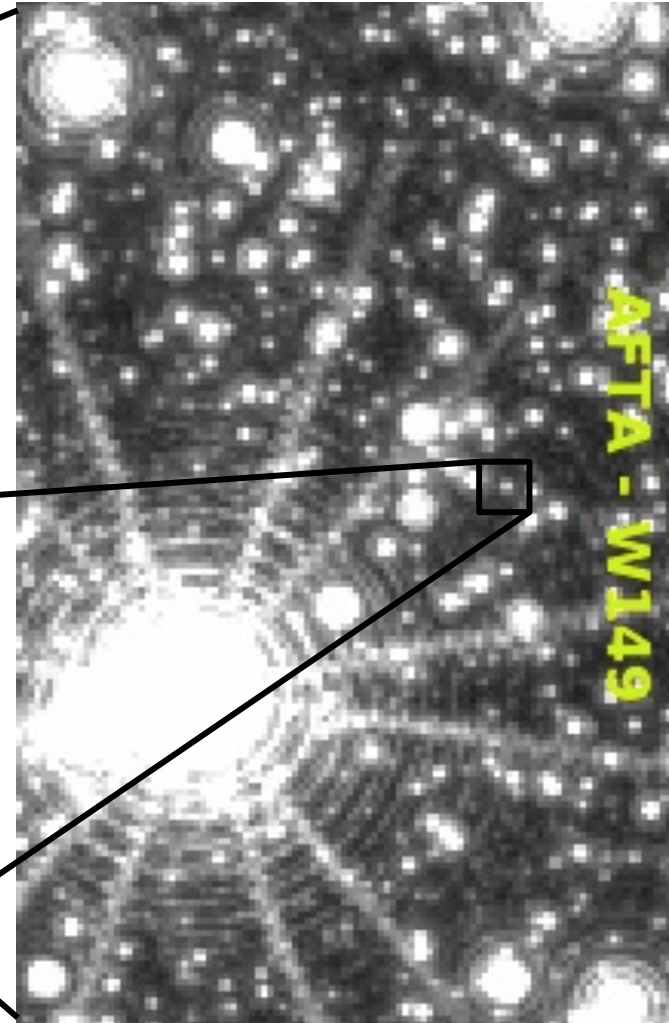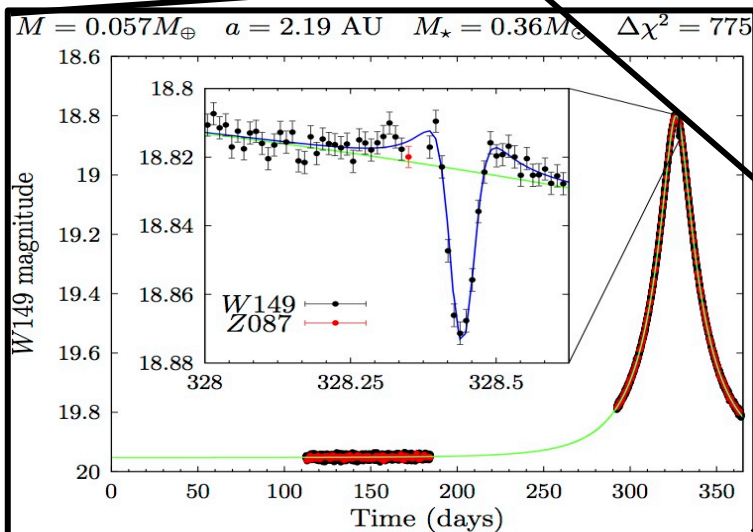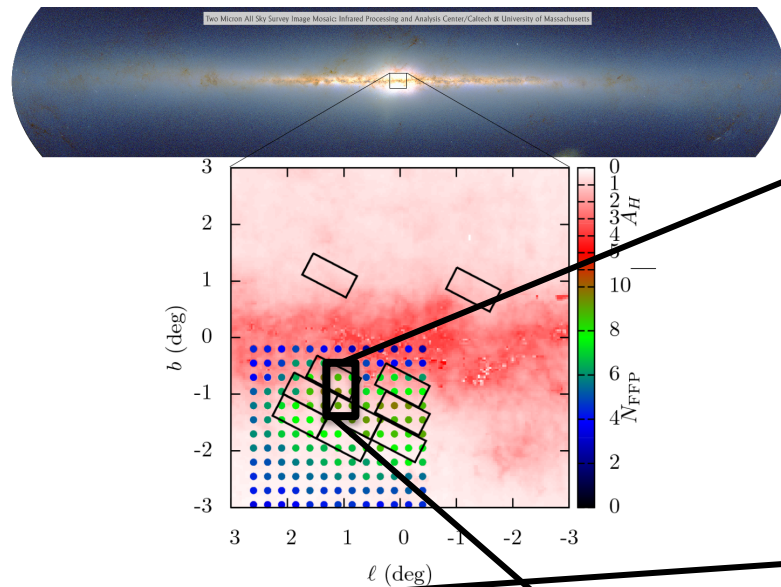# WFIRST Microlensing Survey: A To Do List

Scott Gaudi

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(OSU)

WFIRST Microlensing Survey.

Why?

Science Questions:

1. How do planetary systems form and evolve?
2. What is the frequency of habitable worlds and what determines their habitability?
3. What kinds of unexpected systems inhabit the cold, outer regions of planetary systems?

Primary Science Objective:

Complete the statistical census of planetary systems in the Galaxy, from the outer habitable zone to free-floating planets, including analogs of all the planets in the Solar System with the mass of Mars or greater.

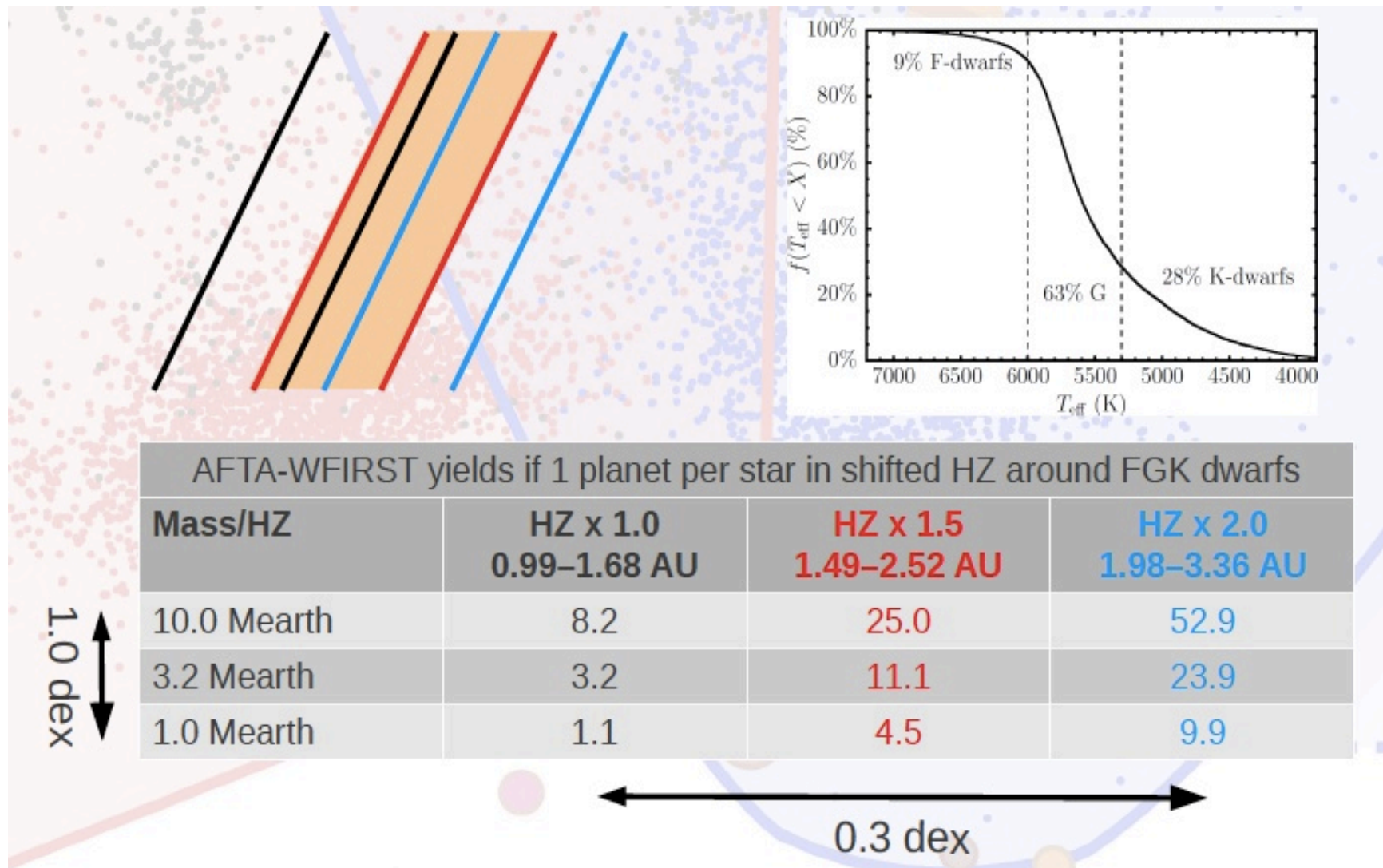# In other words, find lots of planets over a broad a region of parameter space as possible!

Science Requirements.

1. Survey an effective number of at least 1500 stars for bound planets in the mass range 0.1-10,000 Earth masses, including at least 150 stars for planets with mass <3 Earth masses.

2. Capability to detect bound planets down to 0.1 Earth masses.

3. Detect at least 20 free floating Earth mass planets, if there is one per star in the Galaxy.

4. Ability to measure masses of at least XX% of the planet host stars to a precision of at least 20%.

Checklist: Survey Planning.

- **Yields.**
  - **Habitable planets.**
  - **Parameter uncertainties.**
  - **Systematics.**
- **Optimization.**
  - **Fields, cadence, filters.**
- **Calibration.**
- **Follow-up.**
- **Auxiliary Science Data.**

Habitable Planets.

AFTA-WFIRST yields if 1 planet per star in shifted HZ around FGK dwarfs			
Mass/HZ	**HZ x 1.0** **0.99–1.68 AU**	**HZ x 1.5** **1.49–2.52 AU**	**HZ x 2.0** **1.98–3.36 AU**
10.0 Mearth	8.2	25.0	52.9
3.2 Mearth	3.2	11.1	23.9
1.0 Mearth	1.1	4.5	9.9

1.0 dex

0.3 dex

(Courtesy of Matthew Penny)

Some Uncertainties.

- **Event rate.**
  - **Stellar luminosity function.**
  - **Mass distribution.**
  - **Lens population.**
  - **Planet distribution.**
  - **False positives?**
- **Photometric/astrometric precision.**
  - **Statistical.**
  - **Systematics.**

Checklist: Survey Execution.

- **Input catalog**
  - Star properties
  - Extinction map
  - Calibrators (astrometric, etc.)
- **Pipeline.**
  - Source identification.
  - Image subtraction.
  - Light/astrometry extraction.
  - Detrending/systematics removal.
  - Event and planet detection.
  - Automated efficiencies.
- **Database and data products.**
  - Mirror databases.
  - "Moment" curves.
  - Full, stacked, supersampled images.
  - Postage stamps
  - Calibration data.
- **Outreach**
  - Planethunters?

To do: Practical.

- **General.**
  - – **Science requirements and flowdown.**
- **Observational.**
  - – **HST images of target fields (multiple filters).**
    - • **~4 times the PHAT survey area (3300 orbits!?!)**
    - • **Immediate science: spatial variation of metallicity, MF, blue stragglers, young stars, CVs, WD...**
  - – **Ground-based H-band survey.**
  - – **HST/AO follow-up of ongoing planet detections.**
  - – **Spitzer/K2 parallaxes.**
- **Experimental.**
  - – **Detector lab tests.**

To do: Practical, cont.

- **Theoretical.**
  - Improve models and yields.
  - Parameter uncertainties.
  - Optimize survey.
  - End-to-end image simulations.
- Sociological.
  - We need help!